

ON *CALLISTA*, *AMIANthis*, AND *PITARIA*.

By A. J. JUKES-BROWNE, F.R.S., F.G.S.

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THE large group of shells which was called *Callista* by Mörch (1853) and by the Adams Bros. (1857), and *Dione* by Gray (1847), was divided by Römer into three sections (1857 and 1862), which were really genera, for he regarded them as co-ordinate with *Tivela*, *Meretrix*, and *Circe*.¹ His divisions were *Callista* for the *Venus chione* group, *Caryatis* for the *C. tumens* group, which he had called *Pitar* in 1847, and *Dione*, which he restricted to the *Venus dione* group, but included *D. nobilis*, which is the *Cytherea callosa* of Conrad, and for which Carpenter proposed the sub-genus *Amiantis*.

A little later (1876) the whole group was briefly reviewed by Meek, who thought all these divisions might be reunited into one genus under the name *Callista* (Poli & Adams). Of this genus he made six sections or sub-genera, including Römer's three groups, and adding to them a sub-genus *Macrocallista*, and the fossils *Aphrodina* (Conrad) and *Dosiniopsis* (Conrad).

More recently (1902) Dr. Dall published a "Synopsis of the Veneridæ",² in which he regarded most of these groups as separate genera, discarded the name *Callista*, and made a still further sub-division of them so that his genera and sub-genera are as follows:—

1. *Macrocallista*, Meek, with sub-genus *Chionella*, Cossmann.
2. *Amiantis*, Carpenter, with section *Eucallista*, Dall.
3. *Callocardia*, Adams, with sub-genus *Agriopoma*, Dall.
4. *Pitaria*, Römer, em., with sub-genus *Hysteroconcha*.
5. *Aphrodina* (as sub-genus of his *Cytherea*, Bolten).

A comparison of this arrangement with those of Römer and Meek has convinced me that Römer's is much more natural and satisfactory than either of the others. I propose to give my reasons for this opinion and to bring under review some other small groups of shells which are closely allied, viz. the *Tivelina* of Cossmann, the *Lepidocardia* and *Transenella* of Dall, and that for which I proposed the name of *Calpitaria* in 1908.

If it be argued that all these groups are so closely allied that they form no more than one genus, there is little fault to be found with Meek's arrangement, for we need then only exclude *Dosiniopsis*, which indeed he included with some doubt. It may be admitted that the groups above mentioned are linked together by species which combine the characters of two or more of them. At the same time there is no reason why we should not accept the existence of links between groups which it is otherwise convenient to regard as separate genera.

¹ Krit. Untersuchung der Arten des Moll. *Venus*, Cassel, 1857; and Malakozool. Blätter, Bd. viii, 1862.

² Proc. U.S. Nat. Mus., vol. xxvi, p. 335, 1902.

A genus is not a definite creation, but a result of evolution, and the establishment of genera is therefore largely a matter of convenience. Thus, when we are dealing with a large group of shells it is convenient to divide it into several genera, if these can be usefully defined, while, if this very group had not developed so many species, it might have been more convenient to make one genus with several sub-genera. It is not necessary that a genus should be an absolutely isolated group; a genus may be isolated from other recent genera by the extinction of links, though some of these links may occur in fossil faunas; on the other hand, in some cases links between two generic groups may have survived to the present time, and for convenience may have to be included in one of the two genera.

The *Cytherea* or *Callista* group is a large one, and consequently it seems convenient to divide it into a limited number of genera, provided that these can be defined so that they are easily distinguishable from one another. Both Römer and Dall have essayed to do this, and Römer's three divisions seem to me much more natural and convenient than Dall's. Thus I see no reason for separating what Dr. Dall calls '*Agriopoma*' from *Pitaria*, the shells having substantially the same dentition; while the typical *Dione* group agrees much more closely with *Amiantis* than with *Pitaria*. Finally, *Aphrodina* is essentially a *Callista*, as I have previously shown, and has so little in common with the *Venus puerpura* group that I am sure few will follow Dr. Dall's lead in that direction.

An independent examination of a large number of species belonging to these groups led me to the conclusion that they might conveniently be arranged in three sets which could well be regarded as genera. Subsequent reference to Römer's lists of species showed me that my grouping was substantially the same as his, though I can certainly indicate the critical differences between them more briefly and clearly than he did.

These three genera have been widely known by the names of *Callista*, *Dione*, and *Caryatis*, but here we are brought up against that thorny and almost insuperable obstacle of nomenclature. *Callista* cannot be used as if it had been properly established by Poli, because he applied it solely to the animal, or rather to the animals of several Linnæan genera, and did not intend it to be used as a name for any shells belonging to the Linnæan genus *Venus*. Again, if the strict rule of priority is enforced *Callista* cannot be derived from Mörch or Adams because Gray unfortunately published Leach's use of it in 1852, though so used it becomes merely a synonym of *Clausina* (Brown).

The rule of priority, however, is breaking down from the sheer weight of the absurdities and inconveniences with which it is burdened, and of these *Callista* is a striking instance. If discarded it would have to be replaced by the name *Macrocallista*, which presupposes the existence of a *Callista* and was actually proposed by Meek for a mere section of *Callista*. The larger and typical group has then to be included under the name *Chionella*, which was proposed by Cossmann so late as 1887 for a small group of

Eocene fossils. This is surely a *reductio ad absurdum*! For the prevention of such cases as this it seems to me that a relaxation of the rule is required, and that authority should be given for deriving the name from the first subsequent author who used it for the same group to which the current type belongs. This would enable us to pass over Leach and to derive the name *Callista* either from Mörch, whose first species was *C. erycina*, or from H. & A. Adams, whose typical example was *C. chione*. I shall therefore retain the name *Callista* in the hope that the International Zoological Congress will eventually adopt this course.

The name *Dione*, however, cannot stand because it was preoccupied by Hubner in 1816 (Lepidoptera), nor can it be replaced by *Hysteroconcha* as Dr. Dall proposed, for this name is not Fischer's as he supposed. Fischer in his Manuel (1887) used *Dione*, and only mentioned *Hysteroconcha* of "Lang, 1722" in brackets as a synonym, the date showing this name to be pre-Linnæan. I shall demonstrate in the sequel that the *Dione* group is more closely connected with the *Amiantis* of Carpenter than with the *Pitaria* group. Consequently, I agree with Römer in regarding the two former as members of one genus, the name of which will be *Amiantis*.

With regard to the name *Caryatis*, this was also preoccupied by Hubner in 1816; moreover, Römer had himself previously proposed the name *Pitar* for the group, and this, as amended by Dr. Dall and converted into *Pitaria*, should certainly be accepted.

The criteria on which I mainly rely for the establishment of these three genera, *Callista*, *Amiantis*, and *Pitaria*, are (1) the existence in the two latter of a channel leading from the pit between the anterior laterals of the right valve below the anterior cardinal into the first interdental socket, (2) the position and shape of the left posterior cardinal, (3) the form and direction of the pallial sinus. Neither the characters of the external surface nor the bridge-connexion of the anterior and posterior cardinals in the right valve are to be depended upon, though of course they are useful points in diagnosis. So also is the existence of a definite escutcheon in *Amiantis*.

Relying on the characters of the dentition only, the three generic groups may be distinguished as follows:—

In *Callista* there is no connecting channel; the left posterior cardinal is short, high in the middle, and confluent with the nymph.

In *Amiantis* there is a channel under the right anterior cardinal; the left posterior cardinal is long, highest at the end, and confluent with the nymph (as in *Callista*).

In *Pitaria* there is a channel as in *Amiantis*, but the left posterior cardinal is generally more or less separate and slightly curved, so as to extend across the hinge-plate to its inner margin.

There are, however, some exceptions to these rules or generalizations. Thus, *Callista aurantiaca*, Sow., has the fosse and channel of an *Amiantis*, though in all other respects it is a *Callista*. It may, therefore, be regarded as to some extent a link between the two genera, but I do not propose to give it a sectional name, as that would be magnifying the importance of a single structural character.

Another exceptional shell is *Callista vulnerata*, Brod., a rather rare form from the Pacific coast of America. This has the external aspect of a *Callista*, and was so classed by Römer, but inside it presents the dentition of *Pitaria*, and was properly referred to that genus by Dr. Dall in 1902.¹ Moreover, as pointed out by the latter, it is remarkable for having its inner margins irregularly crenulated, a feature not found in any other member of either genus. On account of these peculiarities I propose to separate it as a sub-genus of *Pitaria* under the name of *Callizona*, from its purple marginal band of colour, which is often reduplicated as a zone along the lines of growth.

A more important and inconvenient exception to the discrimination of *Amiantis* and *Pitaria*, as above formulated, is that of *Pitaria tumens*, the very type of the latter genus; for in this shell the left posterior cardinal resembles that of *Amiantis* in being confluent with the nymph along its whole course, and in this respect differs from most other species of *Pitaria*. There is also another point of difference between *P. tumens* and its congeners, this being the form of the pallial sinus, which is long, horizontal, linguiform, and pointed at the anterior end, like that of *Amiantis callosa* and *A. dione*.

Pitaria tumens therefore combines some of the features of *Amiantis* with some of those which are distinctly characteristic of most other *Pitaria*, but it must remain the type of the latter because it is the original 'Pitar' of Adanson. We are therefore in this predicament, that the majority of the species composing the genus *Pitaria* differ from the genotype in two important particulars, i.e. in the position of the left posterior cardinal and in the possession of a short rounded or bluntly angular sinus; while the genotype only differs from a typical *Amiantis* in certain external characters, such as its finer surface sculpture, the exsert lunule, and absence of escutcheon.

Some may think that the best plan would be to unite the *Pitaria* and *Amiantis* groups, and to make only one genus of them, but this would obscure the fact that there are two essentially distinct groups linked together by a few intermediate forms. Moreover, I regard the complete separation of the left posterior cardinal and its extension across the hinge-plate as a character of much importance, because it links *Pitaria* with *Dosinia*, and suggests that the latter has been evolved from the former.

There is also another point of difference between the typical *Pitaria tumens* and the numerous species which have a free right posterior cardinal; for in the former the cardinals of the right valve are separate from one another, like those of *Callista*, while in the latter the anterior and posterior cardinals are more or less united at the top to form an arch over the median tooth. This is markedly the case in the species *citrina*, *pellucida*, and *subpellucida*, the arch in these being really as complete as it is in the shells which Dr. Dall separated in 1902 under the name of *Agriopoma*. In the species *lata*, *obliquata*, and *inflata*, the connecting bridge is lower and slighter, and

¹ Proc. U.S. Nat. Museum, vol. xxvi, p. 388.

in some specimens it is either absent or was so slight as to have been broken and detached; the same is the case with the West Indian *fulminata* (Menke). There is, in fact, every gradation between a complete arch and an incomplete one, proving that the character is of little value as a basis of generic or sub-generic distinction.

Dr. Dall based his *Agriopoma* group on three characters: (1) a continuous cardinal arch in the right valve, (2) a chalky shell without coloration, (3) an angular pallial sinus; and he placed it as a sub-genus of *Callocardia*, taking *Texasiana*, Dall, as the type and excluding *P. fulminata*. It is clear, therefore, that his small group of American shells is not the large group which I distinguish by another set of characters, and for which I now propose the name *Pitarina*, indicating *P. citrina* as the type. This I regard as a section of *Pitaria*, distinguished by a free oblique posterior cardinal in the right valve and a short pallial sinus; the valves are frequently coloured with brown markings, and there is often a complete cardinal arch in the right valve.

So far as I can ascertain, there are only five other reputed species of *Pitaria* which agree with the type. One of these is *P. cor*, Römer (*non* Hanley), which only differs from *tumens* in being more trigonal in shape, and may be regarded as a mere variety; another is *P. rufescens*, which seems only to differ in colour, but is said to come from the Philippine Islands, while *tumens* is a native of West Africa. The third is *P. virgo*, which also comes from West Africa and differs very little from *tumens*, but in which the posterior cardinal is not quite so completely confluent with the nymph. The other two species are *P. manillæ*, Sow., and *P. tumida*, Sow., both of which are trigonal and concentrically ribbed. It is therefore these five species or varieties which, with *P. tumens*, will form *Pitaria*, *sensu stricto*. The true *Cytherea cor* (Hanley) is a very different shell from that above-mentioned.

We cannot leave the *Pitaria* group without taking notice of the shell described by A. Adams under the name of *Callocardia*, and of certain other shells which have been associated with it. *Callocardia* was founded in 1864 on a single left valve, and Adams thought that it did not possess an anterior lateral tooth, for he distinctly wrote "dentibus lateralibus nullis".¹ In 1883 (Challenger Reports, Mollusca) Mr. E. A. Smith doubtfully referred three new species of shells to *Callocardia*, but in the following year Dr. Dall proposed the genus *Vesicomys* for these and another new form (*V. venusta*, Dall).² In 1888 Mr. G. B. Sowerby, having obtained perfect examples of the original species *Callocardia guttata*, pointed out that its dentition agreed more closely with that of *Caryatis* than with that of *Miocardia*, near which it had been placed by Adams. In 1900 Mr. Smith confirmed Sowerby's view,³ and figured the hinges of both valves of *C. guttata*; indeed, he went farther and

¹ Ann. Mag. Nat. Hist., vol. xiii, p. 307, 1864.

² Bull. Mus. Comp. Zool., vol. xii, p. 272.

³ Proc. Malac. Soc., vol. iv, p. 81.

declared that so far as the hinge is concerned there is no essential difference between *Callocardia* and *Caryatis*. He also figured the hinge of *Vesicomya lepta* for comparison, but did not discuss the generic affinities of the latter, thus leaving us under the impression that it was akin to *Callocardia*. It is noticeable, however, that he writes of *Vesicomya* as a genus, and that his list of species which probably belong to it comprises all the forms which had been described by Dr. Dall and himself under the names of *Callocardia*, *Vesicomya*, and *Callogonia*.

The figure of the *Callocardia* hinge is not very good, and does not clearly bring out the existence of the anterior lateral in the left valve, but Mr. Smith informs me that it is there—"an erect acute tooth arising from the margin of the hinge-plate." He further tells me that he does regard *C. guttata* as merely a species of *Pitaria*, the fact of the united cardinals in the right valve not reaching the dorsal margin in some species being in his opinion of no great importance. On this point I agree with Mr. Smith, and differ from Dr. Dall, who makes *Callocardia* a genus with a sub-genus *Agriopoma* on the strength of it. I think, however, that the hinge of *Callocardia* has some features which are more than specific, and if it really has an entire pallial line it may remain as a sub-genus of *Pitaria*.

The only other shell which can be placed with *Callocardia guttata* is that described by Dr. Dall in 1889 as *Veneriglossa vesica*, but afterwards regarded by him as a species of *Callocardia*.¹ It was described as having a hinge like *Cytherea*, but with an entire pallial line.

The shell described by Mr. H. B. Preston in 1905 under the name of *Callista* (*Callocardia*) *Birtsi* only resembles *Callocardia* in being a thin white shell with some resemblance to *Pitaria*. Its dentition is like that of *Lamelliconcha* and *Pitaria tumens*; the hinge-plate is deeply excavated and attenuated posteriorly, but all the teeth are very short, tall, and narrow, except the left posterior cardinal, which is a short low inconspicuous lamina under the umbo, and confluent with the nymph. The pallial sinus is obscure, but is rather short and rounded. The lunule is superficial, not impressed, and there is no escutcheon.

There are several shells which are similar to *C. Birtsi*, namely *Caryatis Deshayesi*, Pfr., *C. Hungerfordi*, Sow., *C. pudicissima*, Smith, a fine shell which may be a variety of *Deshayesi* in Mr. MacAndrew's collection, and another unnamed species from the Persian Gulf in Mr. J. C. Melvill's collection. All these are thin, white, oval shells, concentrically striated, and slightly angulated on the posterior slope. For this small group I propose the name of *Leucothea* with *L. Birtsi* as the type, and would place it as a sub-genus of *Pitaria*, as a link between the typical section and *Callocardia*.

The fossil shells described by M. Cossmann in 1886 under the generic name of *Atopodonta* are closely allied to *Callocardia*. When referring to them in 1908 I omitted to notice that P. Fischer had

¹ See Bull. U.S. Nat. Mus., vol. xxvi, p. 353, 1902.

interpreted their dentition in the same manner as Dr. Dall and myself;¹ but as the true construction of the *Callocardia* hinge was unknown to him, he retained the latter in the Cyprinidæ and placed *Atopodonta* with a (?) in the Veneridæ. As I have pointed out, the arrangement and form of the teeth in *Atopodonta* are not quite the same as in *Callocardia*; the former must therefore be regarded as a section of the latter, though no doubt it is really the ancestor of *Callocardia*, and is at present only known to occur in the Eocene of the Paris Basin.

There only remains the genus *Vesicomya* to be considered, and by the kindness of Mr. MacAndrew I have been able to examine a good specimen of *V. lepta*. This has convinced me that *Vesicomya* cannot be placed in the same genus as *Callocardia*, nor even in the same sub-family, for it does not possess any lateral teeth. The hinge-plate is long and narrow, extending beyond the teeth at each end, and turned up slightly on the anterior side of both valves, but this is clearly due to the attachment of the pedal muscle. There are only three teeth in each valve, and these are laterally elongated, pulled out as it were, the united median and anterior of the left valve being both directed forward, while the right anterior is high up near the lunular margin, and the median is placed below it and projects a little beyond it. The right posterior is a double tooth consisting of two separate laminae, of which one is united to the anterior tooth. This arrangement of teeth differs from that of any other genus, but comes nearest to what is found in the fossils *Cyprimeria* and *Cyclorisma*. There is an additional point of similarity in the fact that some species of *Vesicomya* (like *V. lepta*) have no pallial sinus, while others (like *Leeana*, Dall) have a fairly deep one, and for the latter Dall proposed the name *Callogonia*.

Having satisfied myself of the existence and convenience of these generic groups so far as recent shells are concerned, I thought it desirable to re-examine some of the Eocene fossils which were dealt with in a former paper,² in order to see how they could be classified by the hinge characters above indicated.

It will be remembered that a certain number of these Eocene fossils seemed to combine some of the characters of *Pitaria* with some of *Callista*, and that for these I proposed to create a section under the name of *Calpitarina*, with *P. sulcataria*, Desh., as the type. I now find that this estimate of their taxonomic position is curiously confirmed by the form of the left posterior cardinal, which in these species is closely appressed to the nymph for part of its length, but is slightly curved at the end so as to disengage itself and extend across the hinge-plate. It thus occupies a position which is intermediate between that of the same tooth in *Callista* and that in *Pitaria*.

From specimens which I owe to the kindness of M. Cossmann, I find that this is the case with *P. sulcataria* and its var. *Suettonensis*,

¹ Manuel de Conchyliologie, 1887, p. 1088.

² Proc. Malac. Soc., vol. viii, p. 148, 1908.

with *P. ambigua* and with *P. obliqua*, while in the more typical *Pitarina Parisiensis* this tooth is completely, though very narrowly, separated from the nymph. The last-mentioned may therefore be classed as a *Pitarina*, but probably most of the other species referred to *Pitaria* by M. Cossmann in his *Iconographie Complète* of 1907 have an elongate partially free posterior cardinal like *sulcataria*; from his photographic figures this certainly seems to be the case with *P. avia*, *P. Lamberti*, and *P. fastidiosa*.

Furthermore, I find that a few recent species agree with *P. sulcataria* in having a similar left posterior cardinal which is only partially free from the nymph, the upper portion being closely appressed to it. This is the case with *P. rudis*, Poli. *P. Simpsoni*, Dall, *P. indecora*, Phil., *P. varians*, Hanley, *P. hebræa*, Lam., and *P. munda*. Under these circumstances I now regard *Calpitarina* as more closely allied to *Pitaria* than to *Callista*, and consider that this group may be placed as a section of the genus *Pitaria*; and that it includes the recent species above-mentioned.

Another small group of Eocene shells which I found difficult to allocate to any recognized genus was that to which M. Cossmann gave the name of *Tivelina*. The affinities of this little group are undoubtedly with *Callista* and *Amiantis*, and not with *Tivela* as the name implies, and in this opinion I am glad to say that M. Cossmann now agrees with me.

A fresh study of the specimens with which M. Cossmann previously supplied me, and of two others which he has recently sent me, only confirms my previous observations, but shows that the group might be divided into two sections by the dentition of the right valve. One of these would include the type, and agrees with *Amiantis* in having an undercut anterior cardinal and a channel leading from the anterior lateral pit; while the dentition of the other set differs little from that of *Callista*. The first section includes *T. tellinaria*, *T. Dixoni*, *T. rustica*, *T. humerosa*, and *T. gibbosula*; the second would comprise *T. analoga*, *T. subanaloga*, *T. sphenarium*, and *T. distans*.

One common species, however (*T. striatula*), occupies an intermediate position in this respect, the anterior cardinal being deeply undercut, but there is no continuous channel in front of it. Further, there is no association of other specific differences to warrant such a division into sections; on the contrary, they all agree in having a short left posterior cardinal confluent with the nymph, as in *Callista*, a short narrow and nearly entire right posterior tooth, and a short rounded ascending pallial sinus.

These fresh observations only confirm my previous statement that "in *Tivelina* we seem to have a group of shells which has branched off from the common ancestor of *Callista* and *Pitaria*, for in some of the species the hinge resembles that of *Callista* and in some it makes a near approach to that of *Pitaria*. *Tivelina* seems to have been a plastic group, i.e. one which had a special tendency to develop variations while still retaining a certain general facies". I am still able to agree with M. Cossmann in regarding the group as one which is united by a common set of characters, and I am still of opinion

that, "on the whole, *Tivelina* is more nearly allied to *Callista* than to any other genus."

When drawing up the tabular view of genera and sub-genera for my paper on Cretaceous and Tertiary Veneridæ in 1908, I placed *Tivelina* as an independent genus, but I now incline to regard it as merely a sub-genus of *Callista*. Moreover, I think the species *Baudoni*, *elegans*, and *elegantula* should be separated from it and referred to *Callista* itself, from which they do not differ in any essential respect; and in this view I understand that M. Cossmann concurs. On the other hand, I regard *T. capsuloides* as a small *Pitaria* belonging to the *Calpitarina* section; for there is nothing in the dentition or the pallial sinus or the shape of the shell to dissociate it from such species as *P. sulcatoria* and *P. Parisiensis*. *Meretrissa* (*depressa* and *dubia*) must also be separated and placed under the genus *Meretrix*.

While comparing the shells of *Tivelina* with the smallest species of *Callista*, I came across the very small shells which have been separated by Dr. Dall as a distinct genus under the name of *Transenella*,¹ and I noticed that the dentition of *Tr. Conradina* (his type) is very like that of some species of *Tivelina*, i.e. those which most resemble *Callista*. The chief differences are that in *Transenella* the left posterior cardinal is rather longer and is partially free from the nymph, and that the valve-margins are finely and tangentially grooved, whereas in *Tivelina* they are smooth. It appears to be this marginal grooving which has induced Dr. Dall to regard *Transenella* as a genus, but I do not agree in considering this character to be of generic importance. Such striation has probably less embryological and structural value than crenulation of the margins, and yet both smooth and crenulated margins are found in the genera *Circe* and *Sunetta* as well as in *Astarte*. Moreover, I have discovered that similar tangential grooving occurs in *Callista pannosa*, Sow., and in *C. puella*, Carp., shells from the Pacific coast of Central and South America, which Dr. Dall has not hesitated to class as '*Macrocallista*' (*Chionella*), which is his equivalent for *Callista*. In the shells which I believe to be *puella* the grooves are clearer than they are on the thicker shells of *C. pannosa*, but probably they are equally distinct on the young of the latter. I also find them to be well developed in *Callista angulifera*, Sow., with specimens of which I have been furnished by Mr. G. B. Sowerby, but unfortunately the locality of this species is unknown. As all the other species which possess this peculiar striation have their home in American waters, it is probable that *C. angulifera* is also an American shell. Dr. Dall has described four species from the Caribbean Sea, and one (the '*Psephis*' *tantilla*, Gould) from the Pacific coast; the three species above mentioned raise the number to eight, and they certainly form a small group, section, or sub-genus of *Callista*, which may well be recognized under the name of *Transenella*.

Another shell which certainly belongs to the *Callista* group and

¹ Proc. U.S. Nat. Mus., vol. vi, p. 340, 1883; vol. xxvi, p. 348, 1902.

bears much external resemblance to *Tivelina* is the *Venus Africana* of Philippi (= *Chione floridella*, Gray). This species was separated by Dr. Dall in 1902¹ under the name of *Lepidocardia*, and was placed for some inscrutable reason as a sub-genus of his *Cytherea* (Bolten). I cannot see any kind of connexion between *C. Africana* and *Venus puerpura* or *V. plicata*, with which it seems positively absurd to place it. In its small size, faint striation, compressed form, and posterior attenuation it resembles *Tivelina*, but the hinge differs in the close approximation of the anterior laterals to the cardinal teeth; the pallial sinus again agrees in form and direction with that of typical *Callista*. The hinge-plate is very short and the cardinal teeth are more equally divergent in both valves, the median occupying a more central position than in *Callista* or *Tivelina*. It certainly has characters of its own which are not found in any other species, and which entitle it to sectional or sub-generic rank in the genus *Callista*.

SUMMARY.

The conclusions arrived at in the preceding pages may be summarized in the form of a descriptive synopsis of the genera, thus:—

Genus CALLISTA (Poli), H. & A. Adams, 1857.

Type. *Venus chione*, Linn.

Synonyms: *Chione*, Gray (not Megerle, 1811); *Dione*, Gray, 1847 (not Hubner, 1816); *Chionella*, Cossmann, 1887.

Shell oval, rarely trigonal, smooth or concentrically grooved, with minute discontinuous ingrained radial striæ beneath a glossy vernicose periostracum. Lunule circumscribed, but escutcheon not defined. Hinge of left valve with a strong anterior lateral and three cardinal teeth, of which the two anterior are united to form a Λ , and the posterior is confluent with the nymph; in the right valve there are two anterior laterals with a pit between them and three separate cardinals, the median being nearer the anterior than the posterior, and the latter is superficially grooved (only bifid in *Aphrodina*). Pallial sinus generally wide, horizontal, and pointed in front. Margins of valves smooth (except in *Transenella*). Anterior left and posterior right dorsal margins grooved to receive bevelled edges of opposite valve.

Section *Macrocallista*, Meek, 1876. Type, *Venus nimbosa*, Solander (= *V. gigantea*, Gmel.). Shell much elongated, pallial sinus short.

Section *Callistina*, J.-Br., 1908. Type, *Cytherea plana*, Sow., Cretaceous fossil. Left posterior cardinal long and not confluent with the nymph. Left anterior lateral elongate, narrow, corrugated; right laterals obsolete. Pallial sinus ascending.

Sub-genera.

Aphrodina, Conrad, 1868. Type, *Meretrix tippana*, Conrad.

Shell like *Callista*, but finely striated, and without trace of radial striation. Left posterior cardinal partially free, and anterior cardinal

¹ Proc. U.S. Nat. Mus., vol. xxvi, p. 356.

curving forward. Right anterior cardinal pointing to lower anterior lateral, posterior broadly bifid. Pallial sinus deep, ascending. This group is Cretaceous and Eocene, including *C. nitidula*, Lam., *C. nitida*, Desh., *C. tranquilla*, Desh., and *C. corbulina*, Desh.

Lepidocardia, Dall, 1902. Type, *Venus Africana*, Phil. (= *floridella*, Gray).

Shell ovate, compressed, posteriorly attenuated, nearly smooth, but showing radial striæ. Hinge-plate short, with crowded teeth, the left anterior lateral long and reaching nearly to top of anterior cardinal. Pallial sinus horizontal, pointed. No other species known.

Tranzenella, Dall, 1883. Type, *T. Conradina*, Dall.

Shell oval or sub-trigonal, smooth or striate. In left valve three divergent cardinals, the median being thick and triangular; in right valve the anterior is short and underent, the posterior narrow and often entire. Pallial sinus rounded. Valve-margins tangentially grooved. This includes *C. pannosa*, Sow., *C. puella*, Carp., and *C. angulifera*, Sow., besides the species mentioned by Dr. Dall, and there are also some species of Miocene age.

Tivelina, Cossmann, 1887. Type, *C. tellinaria*, Lam.

Shell small, oval, compressed and posteriorly attenuated; surface smooth or finely striate; hinge-plate strong in front, but curtailed behind; cardinal teeth all short; left valve with a strong anterior lateral and three divergent cardinals, of which the median is triangular and the posterior narrow and confluent with nymph; in the right valve the pit of the anterior lateral is sometimes isolated, sometimes continued into a channel which undercuts the anterior cardinal. Pallial sinus small, rounded, and ascending.

Genus *AMIAANTIS*, Carpenter, 1863.

Type, *Cytherea callosa*, Conrad (= *Dione nobilis*, Sow.).

Synonyms: *Dione* (in part), Gray; *Dione*, Römer; *Hysteroconcha*, Lang (in Fischer), pre-Linnæan.

Shell oval, more or less angulated on the posterior slope; surface sculpture of concentric ridges; lunule impressed and circumscribed, escutcheon defined, but very narrow, with raised ligamental margins; ligament long, open, and conspicuous; hinge similar to that of *Callista*, but in the left valve the pit between the anterior laterals is continued into a channel which passes under the anterior cardinal; left median thick and triangular, right median semilunar; nymphs rugose or longitudinally grooved; pallial sinus deep and horizontal.

In *Amiantis* (s.s.) the shell is thick, oval, glossy, and strongly ribbed; the interior is irregularly thickened; the hinge is thick, the right posterior cardinal grooved, the left one long and prominent; nymphs rugose; pallial sinus linguiform and pointed. Only two recent species are yet known, *A. callosa*, Conr., and *A. purpurata*, Lam., but it is represented in the Miocene of Aquitaine by *Cytherea undata*, Bast.

Section *Lamelliconcha*, Dall. Type, *C. concinna*, Sow.

Shell oval, striated or ridged; hinge-plate excavated and attenuated

posteriorly; teeth as in *Amiantis*, but left posterior cardinal deeply grooved; nymphs longitudinally ribbed; pallial sinus linguiform, rounded, or obtusely angular.

This section corresponds with the *Dione* group of Römer, but must, I think, also include one species which has been referred to *Pitaria*, viz. the *Cytherea cor* of Hanley.

Section *Agriopoma*, Dall, 1902. Type, *Cyth. Texasiana*, Dall.

Outer surface dull and chalky; nymphs smooth, median and anterior cardinals of right valve forming a complete arch; left posterior long and partly free, left median narrow. Pallial sinus sharply angular.

Genus PITARIA, Römer, 1857, em.

Synonyms: *Caryatis*, Römer, 1862; *Dione*, Gray (in part).

Shell oval or sub-trigonal, smooth or finely striate; lunule superficial; escutcheon not defined; ligament short and deeply sunk; teeth in left valve like those of *Amiantis*, but posterior cardinal generally more or less separate from the nymph; in the right valve the anterior and posterior cardinals are often united to form an arch over the median; pallial sinus generally short and rounded, often ascending.

Pitaria (s.s.). Type, *Venus tumens*, Gmelin.

Nymphs longitudinally ridged; left posterior cardinal long and confluent; left median triangular; right cardinals separate; pallial sinus deep and pointed. This small group is a link with *Amiantis*.

Section *Calpitarina*, J.-Br., 1908. Type, *Cytherea sulcataria*, Lam.

Left posterior cardinal partly free and oblique; median triangular; right cardinals separate; pallial sinus short and rounded.

Section *Pitarina*, nov. sect. Type, *C. citrina*, Lam.

Nymphs smooth; left posterior cardinal free and crossing the hinge-plate obliquely; pallial sinus short, rounded, ascending; two outer cardinals of right valve forming a complete arch.

Sub-genera.

Callizona, n.subgen. Type, *Callista vulnerata*, Brod.

Shell thick, sub-orbicular, glossy; valve-margins irregularly crenulated; nymphs smooth; hinge strong; left posterior cardinal long and partly free as in *Calpitarina*; right posterior cardinal short and entire, rugose; pallial sinus short and rounded. Only the one species known.

Callocardia, A. Adams. Type, *C. guttata*, A. Adams.

Shell very thin; hinge-plate narrow and excavated between the teeth; the united cardinals in each valve forming complete arches which are regularly curved and not angular; left posterior tooth long and free, but parallel to nymph; right posterior cardinal formed of two plates, one of which is continuous with the anterior tooth; pallial line obscure, but believed to be entire.

Leucothea, n.subgen. Type, *Callocardia Birtsi*, Preston.

Shell very thin, dull white, concentrically striated; hinge-plate short, deeply excavated, and narrowed posteriorly; nymphs narrow,

with a single groove; teeth thin and weak; left posterior cardinal short and marginal, under umbo; cardinal arch in right valve complete, and the hinder part of posterior cardinal rising into a sharp peak; pallial sinus short and rounded.

In conclusion, I desire to express my gratitude to Dr. J. C. Melvill and Mr. J. J. MacAndrew for the loan of many specimens from their respective collections, for without this kind assistance I should not have been able to examine so many different species of these genera. I have also to thank Dr. Melvill for reading this paper in MS. and for testing the practical applicability of the descriptions and definition herein set forth.
